Odds Ratio and Risks

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x SAMPLE

y Population

Proportion

RATIO

Indicator

All calculations

are used as

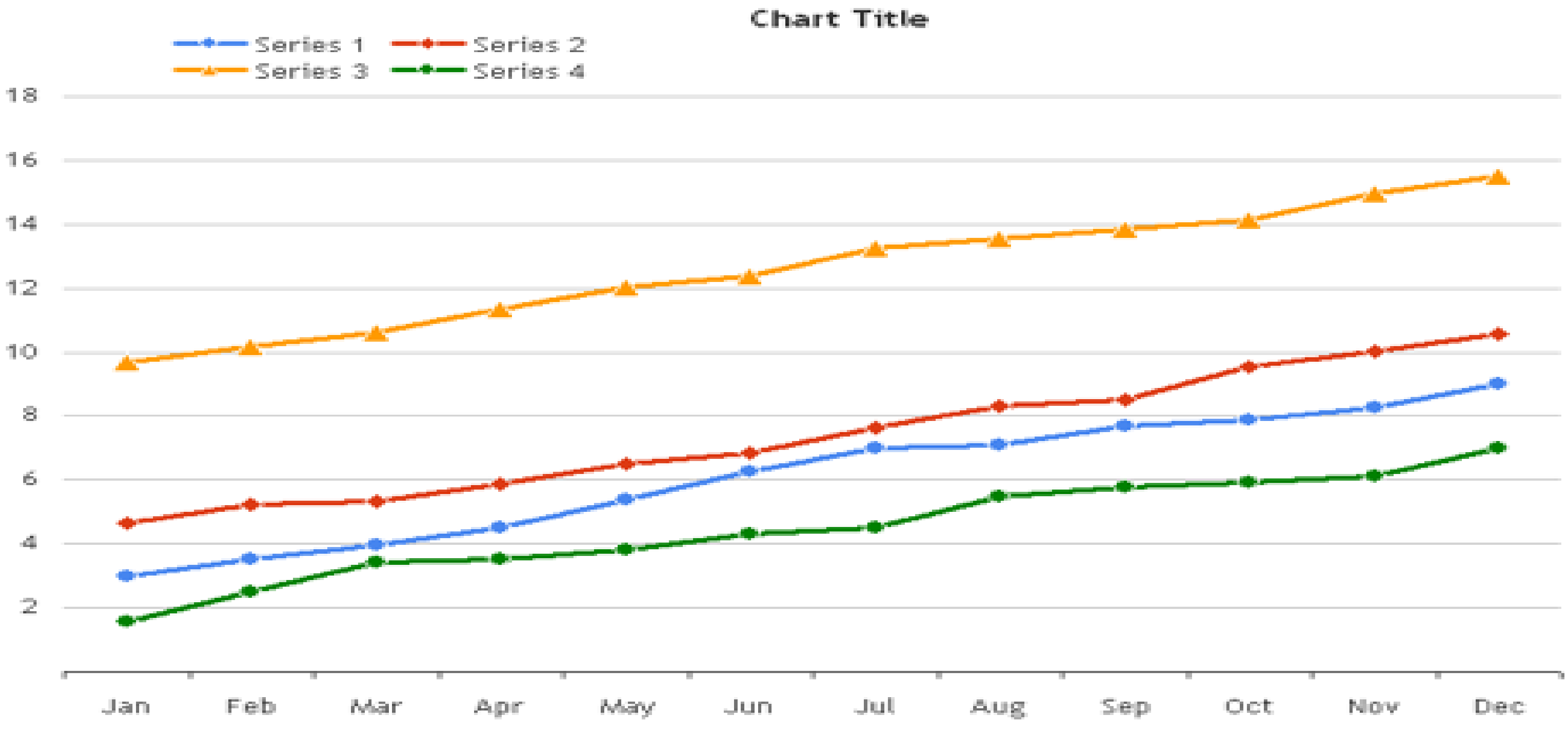
Indicators

Uses of Indicators

1- **Simplify** information about complex phenomena in order to **improve communication**

Uses of Indicators

2- **Monitor** **progress** over time



Uses of Indicators

3- **Indicate** (POINTS) that **something is good or wrong** is going on

Uses of Indicators

4- An indicator must be useful to its intended audience. It must **convey information that is meaningful to decision makers** and in a form which is easily understood

Public and Decision Makers are interested in an answer to the question of

What are the **risks** ?

OR

What is the **probability** that the event would occur or happen

Proportions

For a count to be descriptive of a group, it must be seen **relative to the size of the group**

= N/ D where N is part of D

May be expressed as percentages

$0 \leq \text{proportion} \leq 1$

Eg: 10 out of 20 vs. 10 out of 1000

Male Births = 1,791000

All Births (Male + Female) 1,791000 + 1,703000

= 0.513 (or 51.3%) males

Ratio

= X / Y ; **but X is not part of Y**

Example:

Out of 1000 motorcycle fatalities, 950 victims are men and 50 are women. The sex ratio is:

$$\frac{\text{Number of male cases}}{\text{Number of female cases}} = \frac{950}{50} = \text{19:1 male to female}$$

Ratio Example

Number of men with syphilis, in 1991 was 2,412

Number of women with syphilis, in 1991 was 2,314

Ratio of males to females

= 2,412 / 2,314 = 1.04 : 1

Rate

= N / D where D involves **a measure of time**

N consists of **frequency** of disease **over a specified period of time**

D is the size of population

A rate is a ratio that consists of a numerator and a denominator and in which **time forms part of D**

Population at Risk

<u>It is very important to define your population</u>

- Should include people who are at risk or potential cases

- Would men be a population at risk for cervical cancer?
- Would children be a population at risk in a study assessing the risk of diabetes in adult males?

(Population at risk defined by demographic, geographic, or environmental factors)

Why do we need rates?

For comparisons

Alzheimer's Disease in (2000)

210,000 cases/ 12,419,293 persons in Zarqa

Or 17 cases per 1000 persons

100,000 cases/ 6,271,973 persons in Amman

Or 16 cases per 1000 persons

- Special form of proportion that includes **specification of time**
- **How fast** the disease is occurring in a defined population
- **The basic measure of disease occurrence**
- **In practice, often used interchangeably with proportion without mention of time**

Rate

$$\frac{\text{Number of events in a } \textbf{specified period}}{\text{Number of persons ("population") at "risk" for these events in that } \textbf{specified period}} \times \mathbf{K}$$

How to Select the Multiplier or K

- How common is the event?
  - **K simplifies reading and comparing rates**

Example:

- Breast cancer incidence rate in the US in 2002 was 0.000711.21…..but **typically cancer rates are multiplied by 100,000**
- So, BC incidence rate in 2002 was 71.1 per 100000
  - K for **mortality** is usually **100,000**
  - K for **infant mortality** is usually **1000**
  - K for **attack rates** is usually **100**

At Risk

Individuals are at **risk** of disease if they:

- **Do not have the disease at the start** of the follow up period
- **Are capable of developing the disease**

Risk

Is the probability or chance that an individual will develop a disease over a specified period

*Example: One in eight women (13%) in country **X** will develop breast cancer sometime in their lives.*

Prevalence معدل انتشار

Number of existing cases in a population at some designated time

- Is a **proportion** and therefore has no units
- **Ranges from 0 to 1**
- Numerator includes both new and ongoing cases of disease
- Represents a **cross-sectional 'snapshot'** of the population

Prevalence

- **Extent of the problem** with implications for resource allocation

  Examples:

  – Prevalence of diarrhea in a children's camp on August 2011 was 33%

  – Prevalence of diabetes in a particular school was 15% on June 1, 2013

  – Prevalence of smoking among HU students was almost 20% in 2012

Prevalence

- **Does not estimate risk of disease**
- Is not useful for studies of risk factors
- **Estimates burden of disease**
- Is useful in planning of health services

Incidence معدل الاصابة

Rate of development of disease during a given period of time

Three key elements:

- **ONLY new cases** included in numerator
- **Total population at risk in the denominator**
- **Time element** – period over which new cases developed

Attack Rate

- Alternative form of incidence rate (cumulative incidence).
- Used for diseases observed in a population for a short time period.
- Example: Salmonella gastroenteritis outbreak

Formula: $$\frac{\text{ill}}{\text{ill + well}}$$

Case Fatality Rate

$$\frac{\text{Number of people who die of a disease}}{\text{Number of persons with the disease}}$$

- Useful for acute conditions where no loss to follow-up or competing causes
- Proportion, %
- **Indicator of severity of the disease**
- Could measure benefits of new therapy

At Risk Population

- Defining the denominator (at risk population): who are the susceptible people to develop the disease

Attack rate

- For food-bourne outbreak
  - Number of people who consumed (each) food item served (lunch, dinner) etc,)
  - Number of people who did NOT consume (each) food item

AR for each food item: No. of people (at risk) who develop the disease / No. of people at risk (attended the function)

Attack rate

- AR for consumers of food item (exposed) = ARe
- AR for non-consumers (unexposed)

  = ARu

Calculation of relative risk (RR) for each food item:

RR = ARe / ARu

Calculating an attack rate

- **In an outbreak occurring among people attending a social function or common geographical site:**
  - **Who ate the food**
  - **Who didn't eat the food**
  - **Calculate attack rates for each food item**
  - **For each food item calculate the attack rates among those who ate the food**
  - **For each food item calculate the attack rates among those who didn't eat the food**
  - **Compute the relative risk (RR)**

$$RR = \frac{\text{Attack rate of those who ate the food}}{\text{Attack rate of those who didn't eat the food}}$$

Attack rates

To identify the source of the outbreak from this information, look for an item with:

- A high attack rate among those exposed AND
- A low attack rate among those not exposed (so the difference or ratio between attack rates for the two exposure groups is high); in addition,
- Most of the people who became ill should have consumed the item, so that the exposure could explain most, if not all, of the cases.

	People who ate				People who did not eat				
Food	ill	Not ill	Total	Attack rate %	ill	Not ill	Total	Attack rate %	RR
Chicken	18	10	28	64	28	19	47	60	1.1
Meat	21	16	37	57	25	13	38	66	0.9
Salad	5	45	50	10	43	11	54	80	0.1
Pizza	23	14	37	62	23	14	37	62	1
Cake	45	15	60	75	2	38	40	5	15
Fish	16	7	23	70	30	22	52	58	1.2
Rice	21	16	37	57	25	13	38	66	0.9

RISKS

Attributable Risk

Attributable Risk

Is the amount of risk that occurs because of the exposure

(Attributable risk is the **difference in the probability** of the event in exposed people and the probability of disease in unexposed people)

Age:

Gender:

Income:

Occupation:

Working in a gas station: **1- Yes** **2- No**

X- ray chest: **1- Positive lung cancer**

2- No lung cancer

Gas station	Chest x-ray
1.00	1.00
1.00	2.00
1.00	2.00
2.00	1.00
2.00	2.00
2.00	1.00
1.00	2.00
2.00	1.00
1.00	2.00
2.00	1.00
1.00	2.00
2.00	1.00

		Disease		
		Yes	No	Totals by Exposure status
Exposed	Yes	a	b	(a + b)
	No	c	d	(c + d)
	Totals by Disease status	(a + c)	(b + d)	


DANGER
CONTAINS
BENZENE
CANCER HAZARD

Workers exposed to benzene vapours in gas stations

	Yes lung cancer	No lung cancer	Row Total
Yes Workers Exposed	40	172	212
No Workers Unexposed	18	253	271
Total	58	425	483

Calculate the incidence of lung cancer in both groups

Calculate the attributable risk (fraction)

$$\frac{\text{Incidence exposed} - \text{Incidence unexposed}}{\text{Incidence exposed}}$$

0.6481

Multiply by 100

64.81%

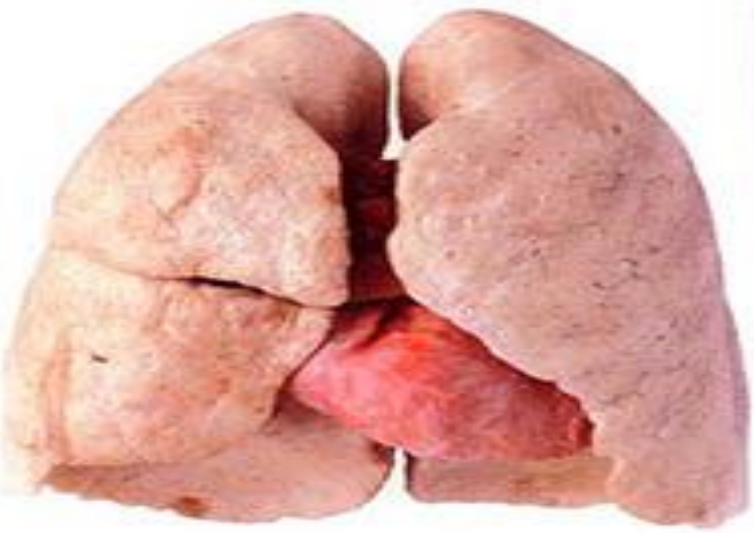
Interpretation

This calculation tells us that, 64.81% of lung cancer in the exposed group (population) is ATTRIBUTED منسوب الى to benzene vapour exposure

Interpretation

It also tells us that, if were able to come up with preventive measures for those workers (e.g; wearing masks during their shift) then we would be able to prevent a fraction of 64.81% of the lung cancer cases in this population






Example

- The incidence of lung cancer among smokers is 0.96/1000/yr.

- The incidence of lung cancer among non-smokers is 0.07/1000/yr.

- **Calculate the Relative Risk and interpret the result**

- The relative risk associated with smoking in this population is 0.96/1000/yr divided by 0.07/1000/yr = **13.7**

- Therefore, smokers are ~14 times more likely to develop lung cancer than non-smokers

- The attributable risk associated with smoking is 0.96/1000/yr – 0.7/1000/yr = 0.89/1000/yr

- **The incidence of lung cancer attributed to smoking is 0.89/1000/yr**

If an agent, such as a mosquito, causes West Nile Fever, for example, people who have been bitten by mosquitoes should have a higher frequency of the disease than those not bitten

On the other hand, the **exposure** could be a **vaccine**, in which case those who have been given the vaccine should have less of a chance of getting the disease than those who did not receive the vaccine—**the vaccine should act as a protective factor**.

Indications of differences in the chance of getting the disease would appear in actual data as different proportions of people having the disease, depending on exposure

In epidemiology, a common type of study is the cohort study, in which a group of people is identified and followed over a period of time

For all individuals in the **cohort**, the investigator keeps track of whether or not they are exposed and whether or not they develop the disease. The information is usually presented in a 2 X 2 table

2 X 2 Layout: Cohort Study

	Develop Disease	Do Not Develop Disease	Total
Exposed	*a*	*b*	*a* + *b*
Not Exposed	*c*	*d*	*c* + *d*

Number of exposed people who develop disease	*a*
Number of exposed people who do not develop disease	
Total number of exposed people	
Number of unexposed people who develop disease	
Number of unexposed people who do not develop disease	
Total number of unexposed people	
Proportion of exposed people who develop disease	
Proportion of unexposed people who develop disease	

Number of exposed people who develop disease	a
Number of exposed people who do not develop disease	b
Total number of exposed people	$a + b$
Number of unexposed people who develop disease	c
Number of unexposed people who do not develop disease	d
Total number of unexposed people	$c + d$
Proportion of exposed people who develop disease	$a/(a + b)$
Proportion of unexposed people who develop disease	$c/(c + d)$

The proportions calculated

(i.e., $a/(a + b)$, $c/(c + d)$) are called risks

Represent the risk that a person has of developing the disease

Another way to say this is that these proportions represent the probability that an individual would develop the disease over a specified period of time

If the proportion of those **exposed** who develop the disease is greater than **(>)** the proportion of those **not exposed** who develop the disease, we would say that the exposure and the disease are **positively associated**

$$\frac{a}{a+b} > \frac{c}{c+d}.$$

If the exposure is to a protective factor, the proportion of those exposed who develop the disease is less than (<) the proportion of those not exposed who develop the disease, and we would say that the exposure and the disease are negatively associated

$$\frac{a}{a + b} < \frac{c}{c + d}$$

If the exposure is unrelated to the onset of the disease, we would expect the proportions to be equal, in which case we would say that there is no association

$$\frac{a}{a+b}=\frac{c}{c+d}$$

At this point we have a way of identifying whether or not there is an association and of determining whether the association is positive or negative, **but we do not yet have a measure of the strength or magnitude of the association**

Relative Risk

The **Relative Risk** is one method of measuring the association between exposure and disease in cohort studies

The relative risk, as the name suggests, **represents the probability of developing a disease among exposed individuals** RELATIVE **to the probability in unexposed individuals**

$$RR = \frac{a/(a+b)}{c/(c+d)}$$

Relative risks allow us to quantify how many times as likely individuals are to get the disease if exposed compared with if they were not exposed

The relative risk (RR) is simply the ratio of the two risks

The risk of disease in the exposed compared with the risk of disease in the unexposed

Interpretation

If the **relative risk is greater than 1**, our interpretation is that the exposed individuals have a higher probability (or risk) of developing the disease **(exposure is associated with the disease)**

The greater the relative risk, the more strongly the exposure is associated with a higher frequency of disease

A **relative risk less than 1** would be interpreted as indicating that the exposure leads to less risk of the disease, i.e., has a protective effect.

The smaller the relative risk, the more strongly it is associated with a lower frequency of disease.

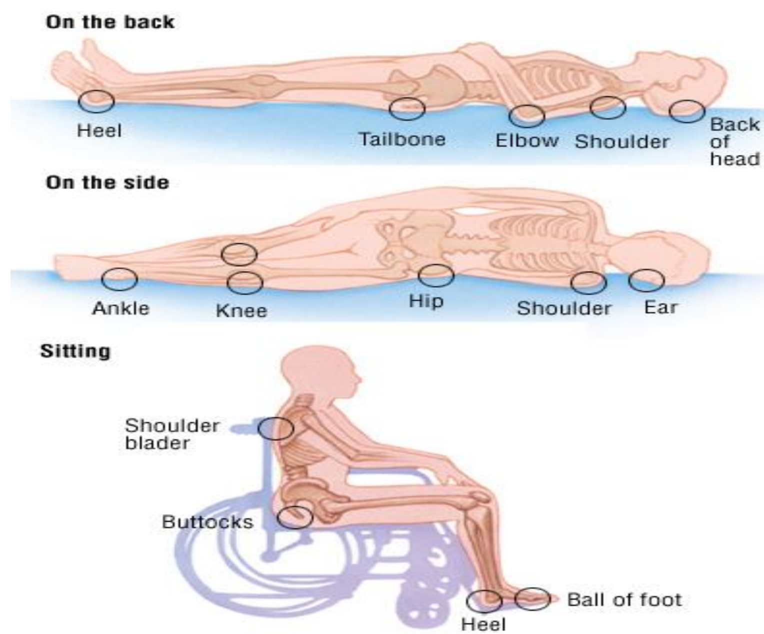
A relative risk of 1 suggests that there is no association between the exposure and the disease

Example

Bedsores and Mortality

– What is the risk of hip fracture patients of dying due to bed sores (study the association between bedsores and death among elderly hip fracture patients)

9,400 patients aged 60 and over were selected. The patients‘ medical charts were reviewed by research nurses to obtain information about whether they developed a bedsore during hospitalization and whether they died while in hospital



Results of Bedsores Study, with Totals

	Died	Did Not Die	Total
Bedsore	79	745	824
No Bedsores	286	8,290	8,576
Total	365	9,035	9,400

- What is the exposure in this example?

- What is the disease?

Number of people with a bedsore who died	79
Number of people with a bedsore who did not die	
Total number of people with a bedsore	
Number of people without a bedsore who died	
Number of people without a bedsore who did not die	
Total number of people without a bedsore	
Proportion of people with a bedsore who died	
Proportion of people without a bedsore who died	

Number of people with a bedsore who died	79
Number of people with a bedsore who did not die	**745**
Total number of people with a bedsore	**824**
Number of people without a bedsore who died	**286**
Number of people without a bedsore who did not die	**8,290**
Total number of people without a bedsore	**8,576**
Proportion of people with a bedsore who died	**79/824 = 9.6%**
Proportion of people without a bedsore who died	**286/8,576 = 3.3%**

Calculate the relative risk of death due to bed sores complications

The probability of death was 2.9 times as high in people with bedsores as in people without bedsores

$$RR = \frac{a/(a+b)}{c/(c+d)} = \frac{79/824}{286/8576} = 2.9$$

In 1945, 1,000 women were identified who worked in a factory painting radium dials on watches. The incidence of bone cancer in these women up to 1975 was compared to that of 1,000 women who worked as telephone operators in 1945. Twenty of the radium dial workers and four of the telephone operators developed bone cancer between 1945 and 1975. The relative risk of developing bone cancer for radium dial workers is:

a. 2

b. 4

c. 5

d. 8

e. 24

The death rate ratio for smokers 15 – 24 cigarettes per day when compared to the nonsmokers is:

	Death rates
Cigarettes per day	per 1000 per year
0 (Nonsmokers)	0.07
1-14	0.57
15-24	1.39
25+	2.27

a. 0.05
b. 19.8
c. 1.98
d. 0.5
e. 1.39

After a party held at the College, many of the faculty and students developed gastroenteritis. All attendees were interviewed by the public health nurse. Calculate the appropriate measure of association for each of the home-made food items shown in the table above. Which food item is most probably the contaminated food?

	Ate specified food			Did not eat specified food		
Food item	Ill	Well	Total	Ill	Well	Total
Macaroni salad	25	15	40	20	39	59
Potato salad	17	38	55	28	16	44
Three-bean salad	43	47	90	2	7	9
Punch	40	52	92	5	4	7
Ice cream	20	1	21	25	53	78

a. Macaroni salad
b. Potato salad
c. Three-bean salad
d. Punch
e. Ice cream

Bladder Cancer Rates in Cigarette Smokers and Nonsmokers

	Bladder Cancer Rates per 100,000 Males
Cigarette smokers	48.0
Nonsmokers	25.4

The relative risk of developing bladder cancer for male cigarette smokers compared with male nonsmokers is

a. 48.0

b. $48.0 - 25.4 = 22.6$

c. $48.0/25.4 = 1.89$

d. $\dfrac{48.0 - 25.4}{48.0}$

e. Cannot be computed from the data given

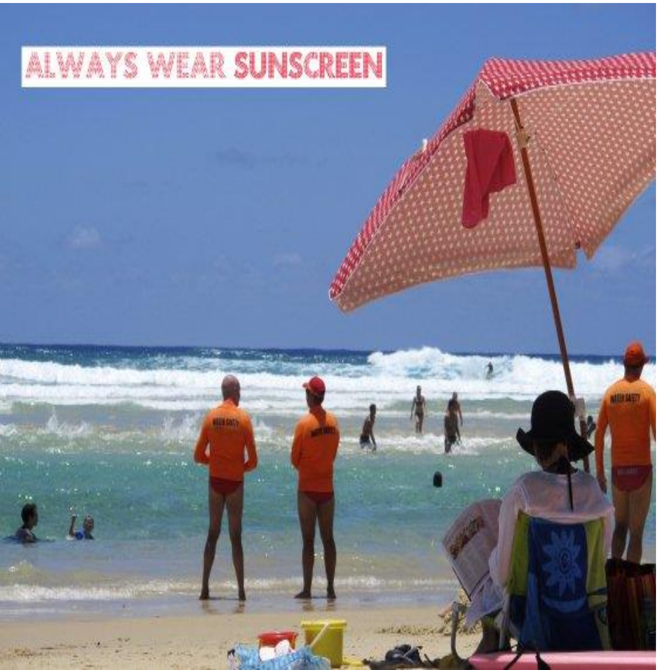
Odds Ratio

The odds ratio is one of a range of statistics used to assess the risk of a particular outcome (or disease) if a certain factor (or exposure) is present

The odds ratio is a relative measure of risk, telling us how much more likely it is that someone who is exposed to the factor under study will develop the outcome as compared to someone who is not exposed

The odds of an event happening is the probability that the event will happen divided by the probability that the event will not happen

$$p / (1-p)$$


ALWAYS WEAR SUNSCREEN

Example: Melanoma

- 1000 persons **observed for 1 year**; 1 acquires melanoma
- Probability of melanoma occurring

  (p) = 1/1000 = 0.001
- Probability of melanoma not occurring

  (1-p) = 1 – p = 0.999
- Odds of melanoma occurring is p/1-p = 0.001/0.999 = 0.001

Odds ratio used in **case-control** and sometimes in **cross-sectional** studies

- Range: 0 to + ∞

- **OR** = 1:No association, no relationship

- **OR > 1**: Positive association, direct relationship, disease is more likely in exposed than in non-exposed-possible risk factor

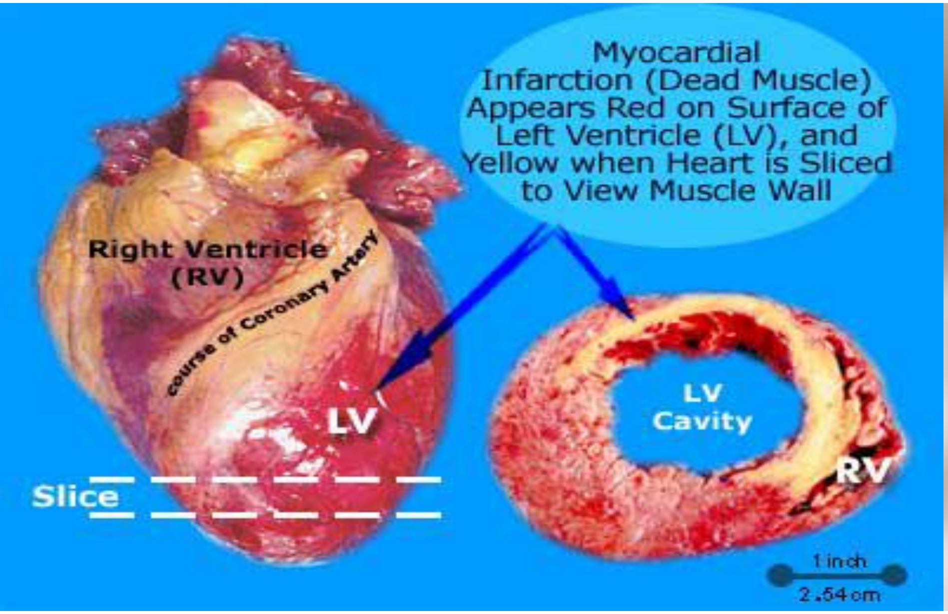
- **OR < 1**: Negative association, indirect relationship, disease is less likely in exposed than in non-exposed-possible protective factor

		Disease		
		Yes	No	Totals by Exposure status
Exposed	Yes	a	b	(a + b)
	No	c	d	(c + d)
	Totals by Disease status	(a + c)	(b + d)	

$$= \frac{\textbf{Odds of disease in exposed}}{\textbf{Odds of disease in non-exposed}}$$

$$= \frac{\{a/(a+b)\}/\{b/(a+b)\}}{\{c/(c+d)\}/\{d/(c+d)\}}$$

$$= \frac{a/b}{c/d} = \frac{ad}{bc}$$


Myocardial Infarction (Dead Muscle) Appears Red on Surface of Left Ventricle (LV), and Yellow when Heart is Sliced to View Muscle Wall
Right Ventricle (RV)
course of Coronary Artery
LV
Slice
LV Cavity
RV
1 inch
2.54 cm

	Myocardial Infarction		
Exposure	Present	Absent	Total
Smoke	100 a	900 b	1000 a+b
Do not smoke	25 c	975 d	1000 c+d
Total	125 a+c	1875 b+d	2000

- Disease odds ratio: odds of MI in smokers/odds of MI in non-smokers

  $= (a/b)/(c/d) = (100/900)/(25/975) = 4.3$

- Is there an association between smoking and MI? How strong? Positive or negative

- Is smoking a risk factor or a protective factor?

There is a positive association between smoking and MI. Smokers are 4.3 times as likely to have MI compared with non-smokers

	Myocardial Infarction		
Exposure	Present	Absent	Total
Do not smoke	25 a	975 b	1000 a+b
smoke	100 c	900 d	1000 c+d
Total	125 a+c	1875 b+d	2000


Association between amount of food eaten and whether feeding is dependent or independent

Feeding		Dependent	Independent	Total
Eats ≤ ¾ of	Yes	59	33	92
Served food	No	17	44	61
	Total	76	77	153

- The probability of dependent feeding in those who eat ≤ ¾ of served food is 59/ 92= 0.641, whilst the probability of independent feeding in those who eat ≤ ¾ of served food is 33/92 = 0.359
- So the odds of dependent feeding in those who eat ≤ ¾ of served food is (59/92)/(33/92) = 1.79

- If the odds are greater than one then the event (dependent feeding in this example) is more likely to happen than not.

- If the odds are less than one then the event is less likely to happen than not

- We can also calculate the odds of dependent feeding in those who do not eat ≤ ¾ of served food as 17/44 = 0.386

- **An odds ratio is used to compare the odds for two groups, in the same way that the relative risk is used to compare risks**

- An odds ratio is calculated by dividing the odds in group 1 by the odds in group 2
- The odds ratio (OR) for dependent feeding those who do (group 1) and those who do not (group 2) eat ≤ ¾ of served food is

$$\text{OR} = (59/33)/(17/44) = 4.63$$

- This odds ratio is greater than one, indeed the 95% confidence interval for the odds ratio is (2.17, 9.97)

- Thus we would conclude that those who eat ≤ ¾ of served food are at significantly increased risk of dependent feeding

Multiple Levels of Exposure

Exposure levels (smoking)	Lung Cancer	No Lung Cancer	OR
3+ Packs a day	300	700	300*975/700*25 =16.7
2 Packs a day	200	800	200*975/800*25=9.75
1 Pack a day	100	900	100*975/900*25=4.3
Never	25	975	1


Women who have a healthy breast removed over fears they might later develop breast cancer may not improve their survival rate, according to new research.

Earlier this year Hollywood star Angelina Jolie underwent surgery to remove her breasts after being told she had an 87 per cent risk of developing breast cancer due to a defective BRCA1 gene and her family history.

Jolie's mother, maternal grandmother and aunt all died from breast or ovarian cancer in their late 40s or in their 50s

A study looking at breast cancer in women compared cases with non-cases, and found that 75/100 cases did not use calcium supplements compared with 25/100 of the non-cases.

Develop a table to display the data

Calculate the odds ratio

Risk factor/exposure	Disease Group	
	Case	Control
No calcium supplement	75 (a)	25 (b)
Calcium supplement	25 (c)	75 (d)

Use the following table to calculate the attributable risk associated with taking a supplement containing folate during pregnancy:

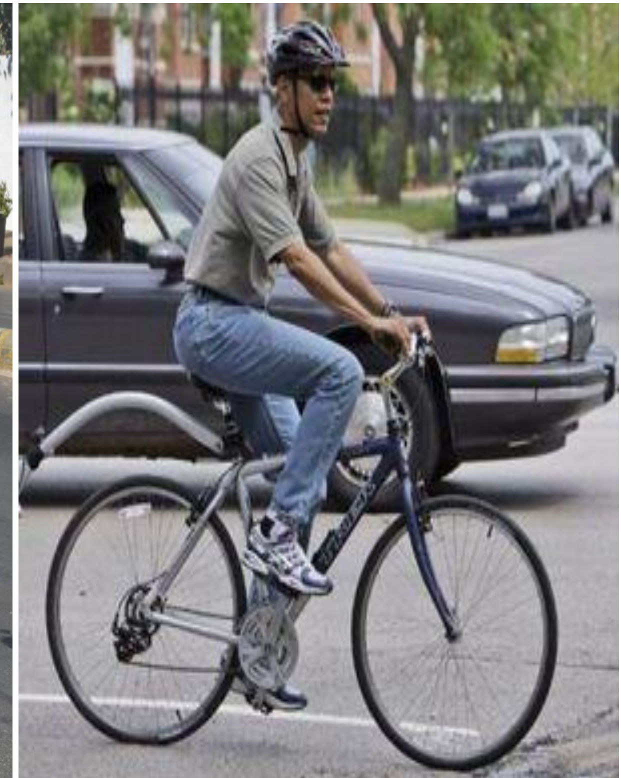
	Annual Death Rates per 100 000	
	Neural Tube Defects	Premature Births
No Folate	631	727
Folate	24	563

- Attributable risk for no folate supplementation on Neural Tube Defects:

  96.2%

- Attributable risk for no folate supplementation on Premature births:

  22.6%



A **case–control** study of bicycle helmets and head injury

	Cases	Controls	Total
No helmet (exposed)	67	140	207
Wearing a helmet (unexposed)	31	126	157
Total	98	266	364